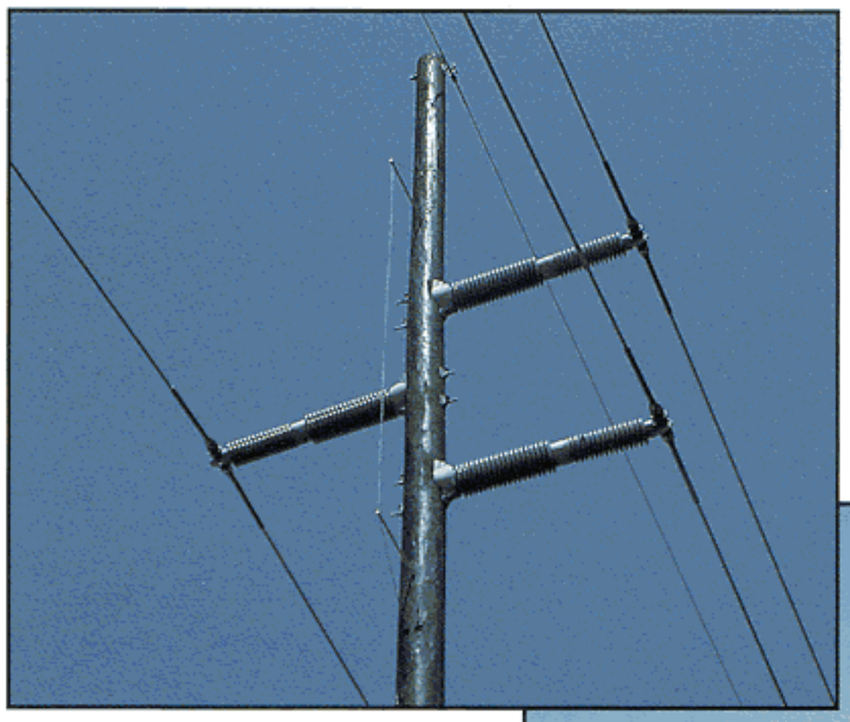
LINE
COMPACTION

Compact Transmission Line Designs for New Construction and Upgrade

LAPP
Insulator Company

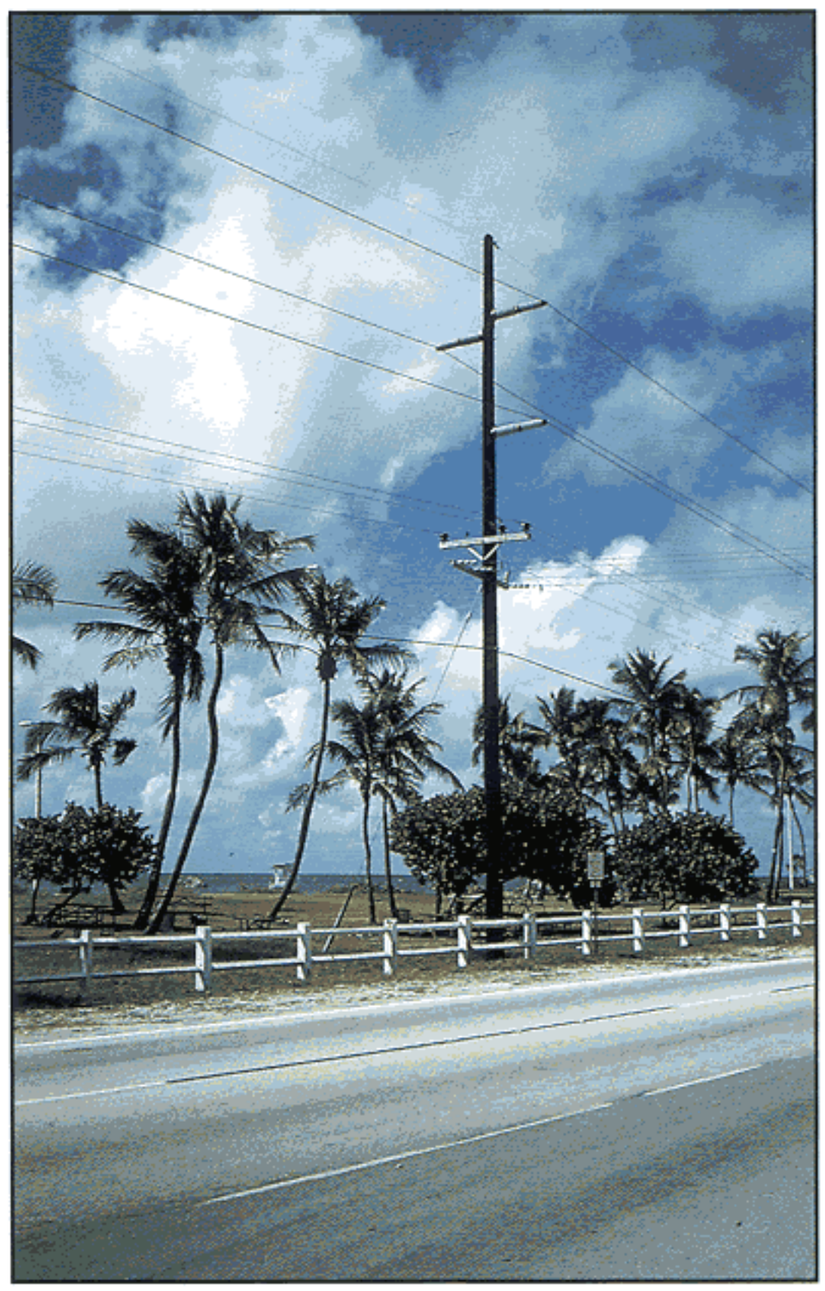
Horizontal Vee Construction Saves $30,000 Per Mile

The placement of steel pole structures adjacent to Expressway Right-of-Way, together with elimination of swing in the insulator assembly, reduced the width of the transmission line path needed for this 230 kV line. Only 60 ft. of ROW is needed even though the line uses 1590 MCM ACSR construction on 1000 ft. spans.



Line Posts on Wood Poles Provide Economical Compact Construction

The simplest insulator system for compact construction is the horizontal Line Post. Many hundreds of thousands of porcelain Line Posts have been used to build compact lines at 115 and 138 kV in the past 30 years. Conductors positioned at the pole by trunnion mounted clamp and slim poles, made practical through low overtuning moment, are hallmarks of line compaction.



Line compaction is the process of reducing the height and width of transmission line structures so that they can be fitted onto narrow rights-of-way.

Insulators are a small part of the transmission line, not as visible as the support structures, nor as expensive as the conductors. Together these two components make up approximately 75% of the installed cost, and both are important in determining overall dimensions. But for the small fraction they represent, insulators have a high degree of importance in determining overall size and cost of a given transmission line.

It was not until the advent of extra high voltage transmission that insulating systems other than conventional single-string suspension assemblies came to be used. With these high voltage lines, the size of the structures and cost of the right-of-way became so high that it was obvious that some way had to be found to compact these lines. Many laboratory investigations were conducted to establish characteristics of air gaps in tower windows. Lapp conducted such tests in their High Voltage Laboratory and similar tests were made in other facilities. It was established that transmission lines could operate at ratios of protective level to operating voltage much smaller than had been used in the past.

At the same time, the need arose to compact lower voltage lines. More and more of these were now being needed to distribute the large blocks of power. In addition, siting of lines became more difficult as public interest grew in their appearance and location. Accordingly, the methods used in reducing the size of EHV lines were now projected back to the lower voltages of 115 through 230 kV.

City Streets Provide Right-of-Way for Narrow Profile 230 kV Line

Concrete poles on this transmission line blend inconspicuously with the architecture of surrounding commercial and residential area. Yet, they carry an important interconnection on a 230 kV transmission system. Line Post insulators are supported by diagonal suspensions bracing back to the pole. Conductor swing is eliminated. The tight phase-to-phase spacing of 8 ft. keeps pole height to a minimum while permitting span lengths to be extended to practical lengths.

COMPUTER COST COMPARISON

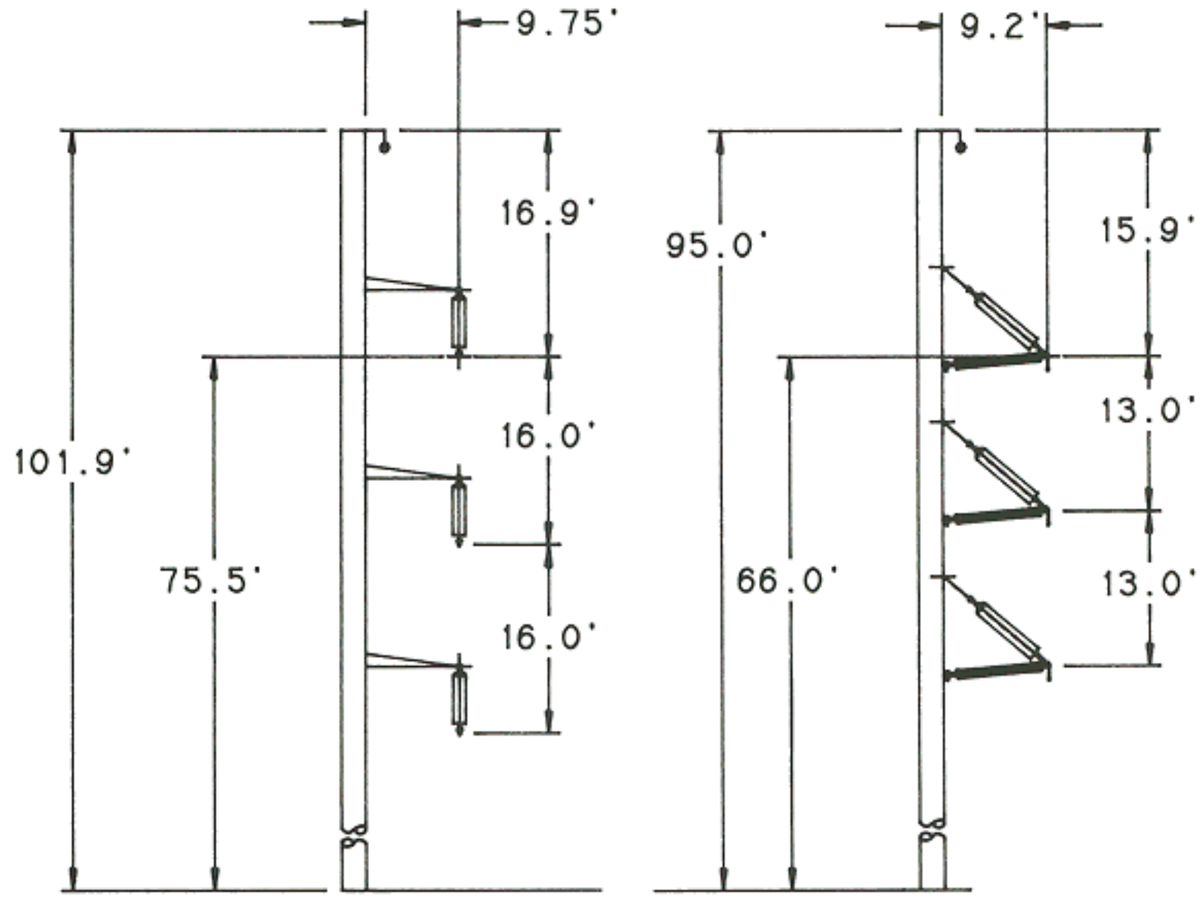
Get an Advanced Look at the Best Way to Build Your Next Transmission Line

A procedure to compare estimated cost of single pole transmission lines using three kinds of insulating systems is available from Lapp. It compares in-place costs of construction utilizing wood, concrete or steel poles and covers the voltage range from 115 to 345 kV.

The three insulating support systems are horizontal posts, horizontal vees and davit arms with standard suspension insulators.

230 kV Single Circuit

Steel Poles



	Suspension	Horizontal Vee
Line Cost ($ per mile)	255,900	224,200
Spans (ft.)	700	700
GLM (ft.-kips)	853	750
Pole Weight (lbs.)	12,518	10,036
Anchor Bolts (lbs.)	750	707
ROW Width (ft.)	58.5	49.7
ROW Cost ($)*	14,185	12,038

*Included in line cost

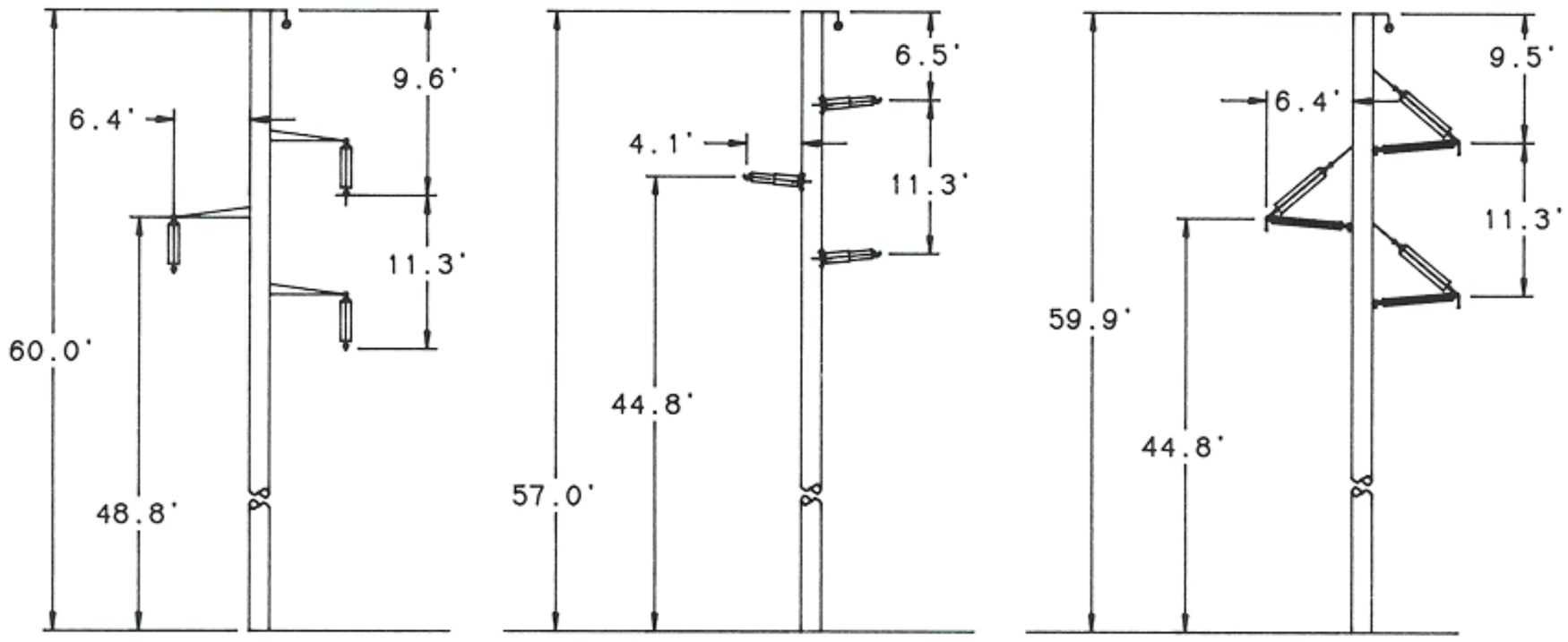
GLM = Ground Line Moment

ROW = Right-of-Way

Data obtained from "Transmission Line Cost Comparison," a Computer Tool, Version 2.0

138 kV Single Circuit

Cost/Mile, $



	Suspension	Line Post	Horizontal Vee
Pole Type			
Steel ($)	182,100	164,200	182,780
Concrete ($)	81,600	82,260	92,130
Wood ($)	69,600	64,250	74,148
Spans (ft.) Ruling/Maximum	360/425	360/425	360/425
GLM (kips)	232	214	222
ROW (ft.)	55.2	45.5	50.2
ROW Cost Per Mile ($)*	26,750	22,050	24,300

Other Possible Span Options

Span Length (ft.) Ruling/Maximum	Steel	Concrete	Wood	Steel	Concrete	Wood	Steel	Concrete	Wood
500/600	159	79	72	145	77	67	157	84	75
600/900	142	78	69	129	76	64	148	82	70
700/850	154	94	†	149	96◆	†	152	96	†
800/1000	164	102	†	159	103◆	†	162	104	†

* ROW cost included in total cost per mile.

† Ground line moments are beyond practical limits for wood poles.

◆ POLYPACE® insulators with 3″ rod required.

Conductor characteristic: Single wire, weight, .46 lb./ft.; diameter, .71 in.

ROW = Right-of-Way

GLM = Ground Line Moment

FULL SCALE TESTING

FOUR

Insulator Proving Grounds

Insulator support systems are subjected to dynamic loads in the transmission line test facility shown at the left. Full-scale tests can be conducted to prove suitability under dropped conductor, dropped ice or broken conductor conditions.

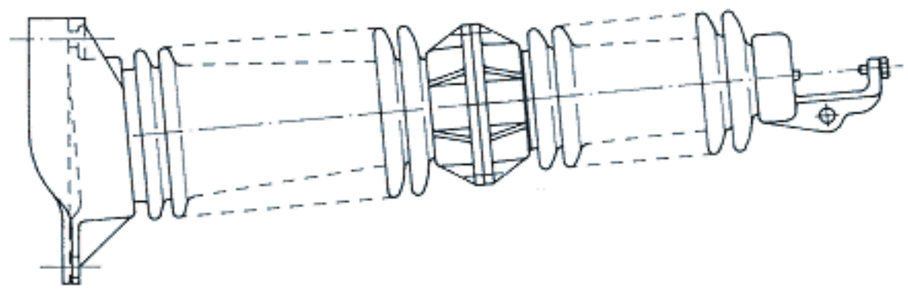
Computer Analysis Insures Reliability

A computer simulation, available only from Lapp, can model performance of a transmission line with horizontal vee supports. The upper limit of wind loading from any direction and under any conductor condition can be determined. This valuable design tool lends assurance to the proper application of this efficient form of transmission construction.

PRODUCTS FOR COMPACTION

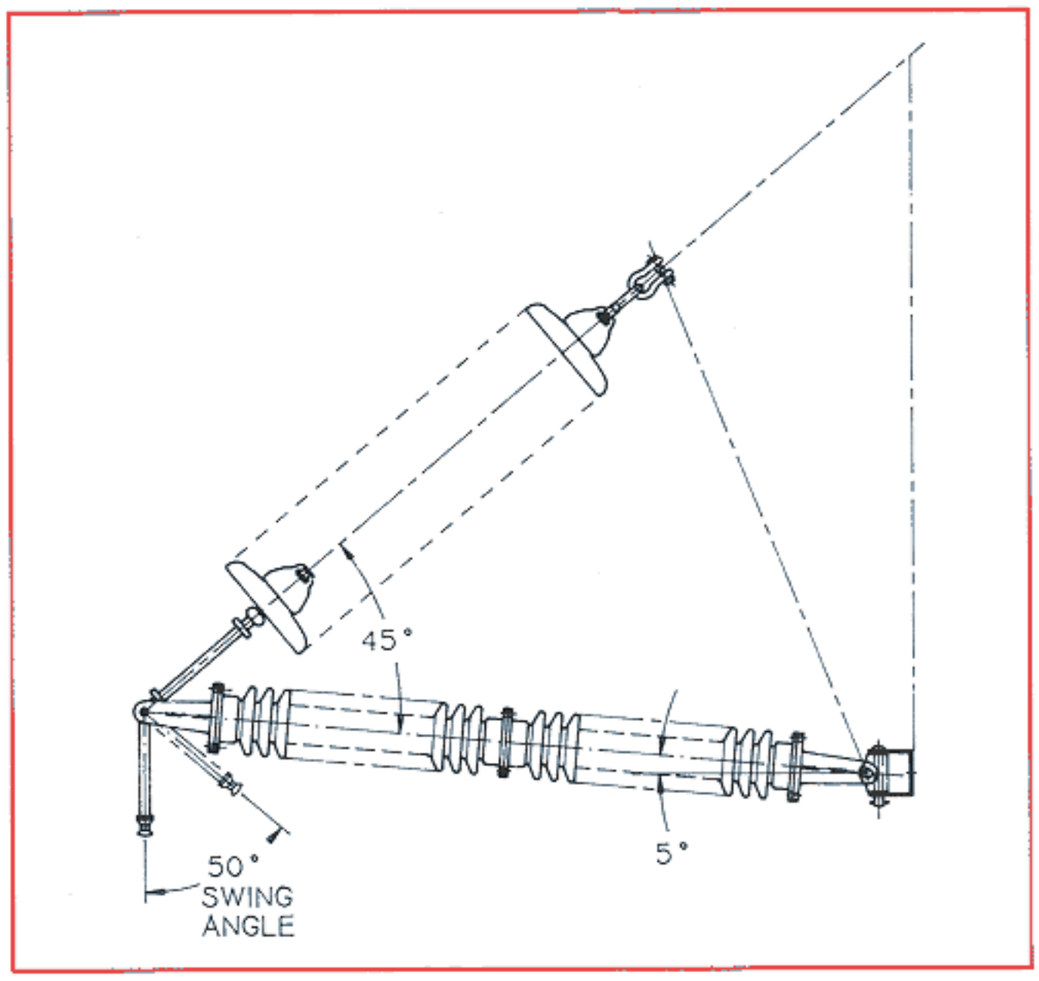
PORCELAIN

Horizontal Line Post



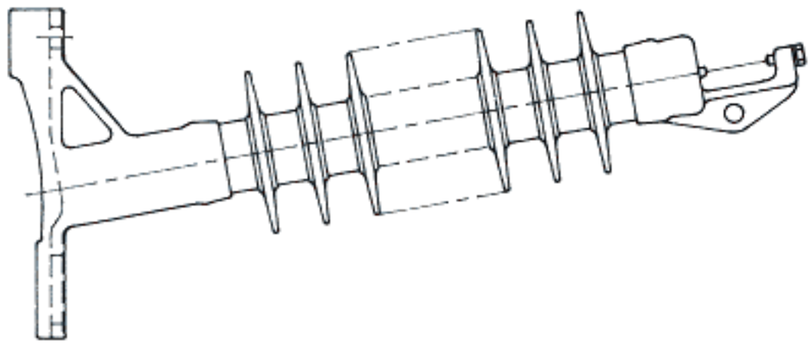
PORCELAIN ►

Strut Insulator



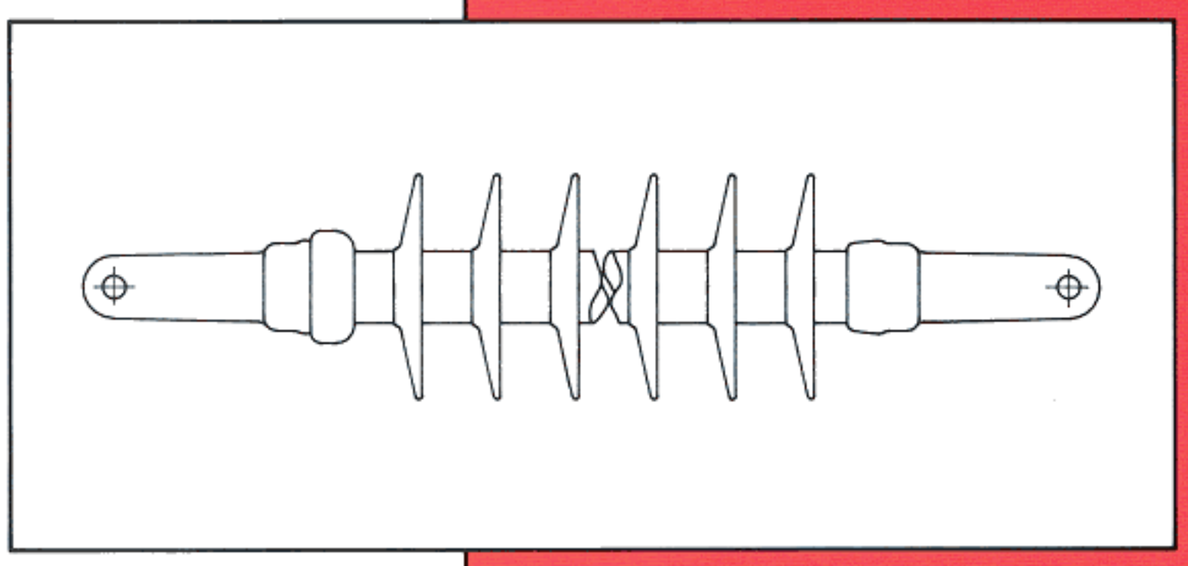
PORCELAIN ►

Horizontal Vee



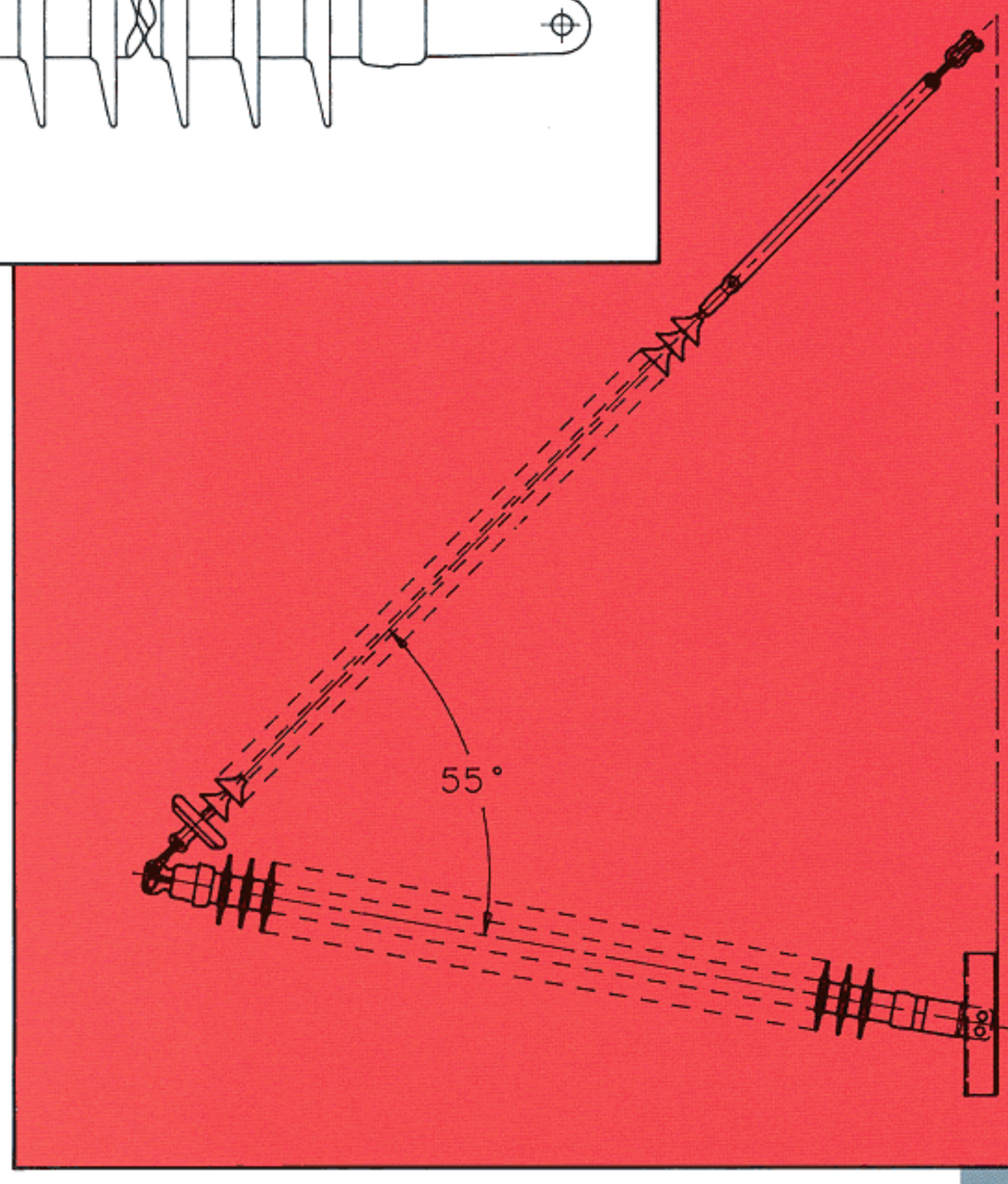
POLYPACE®

Horizontal Line Post



POLYPACE®

Strut
Insulator



When it comes to insulators for compact lines, Lapp has what you need, whether it's horizontal line posts for wood poles, strut insulators for positioning vertical suspension strings or horizontal vee construction. Designs are available in either porcelain or POLYPACE® to position conductors with minimum phase-to-ground distances at the structure and to control phase-to-phase separation clearances. From the lowest transmission operating voltage through 500 kV, Lapp can provide efficient, functional and reliable compact assemblies.

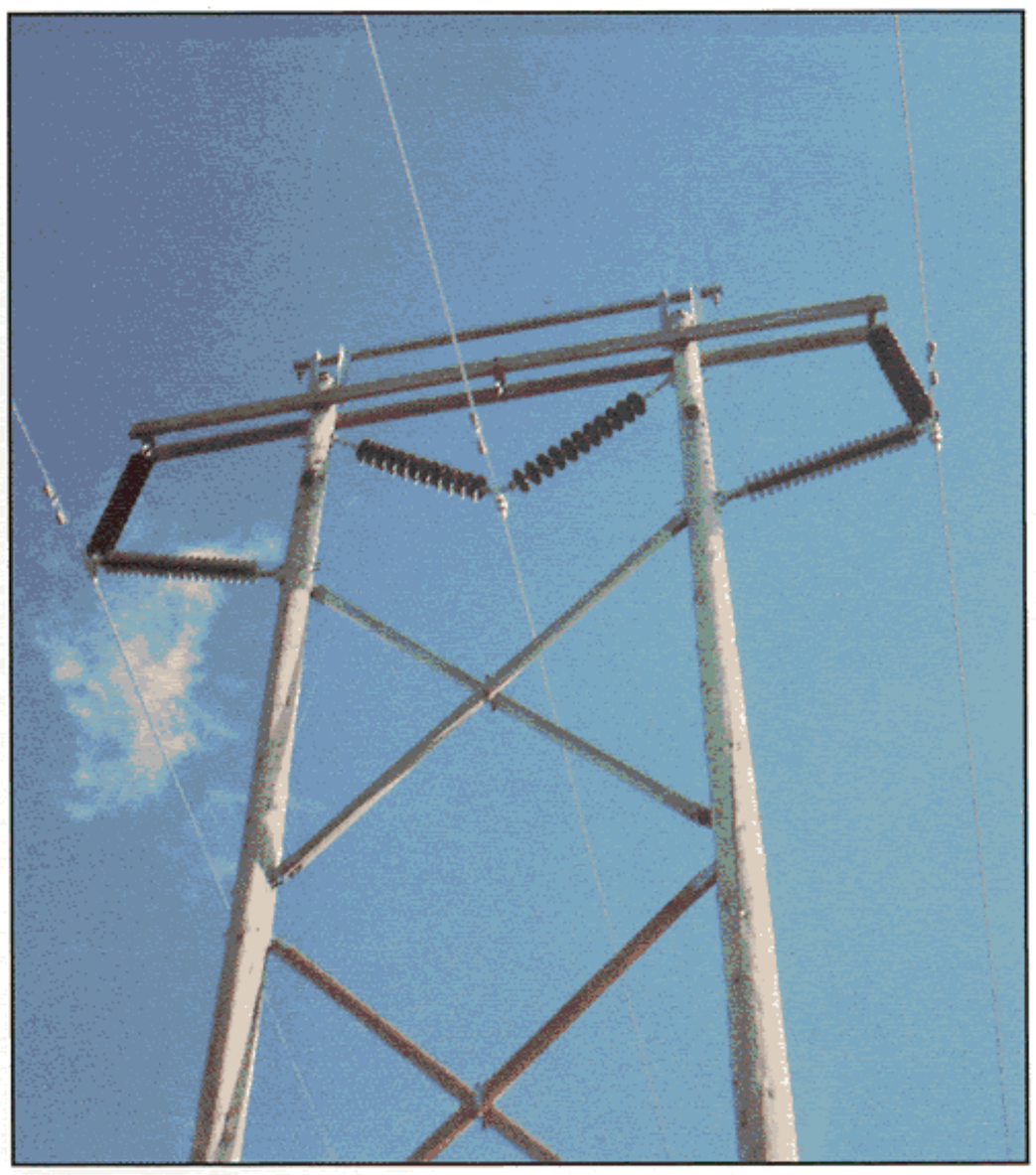
POLYPACE®

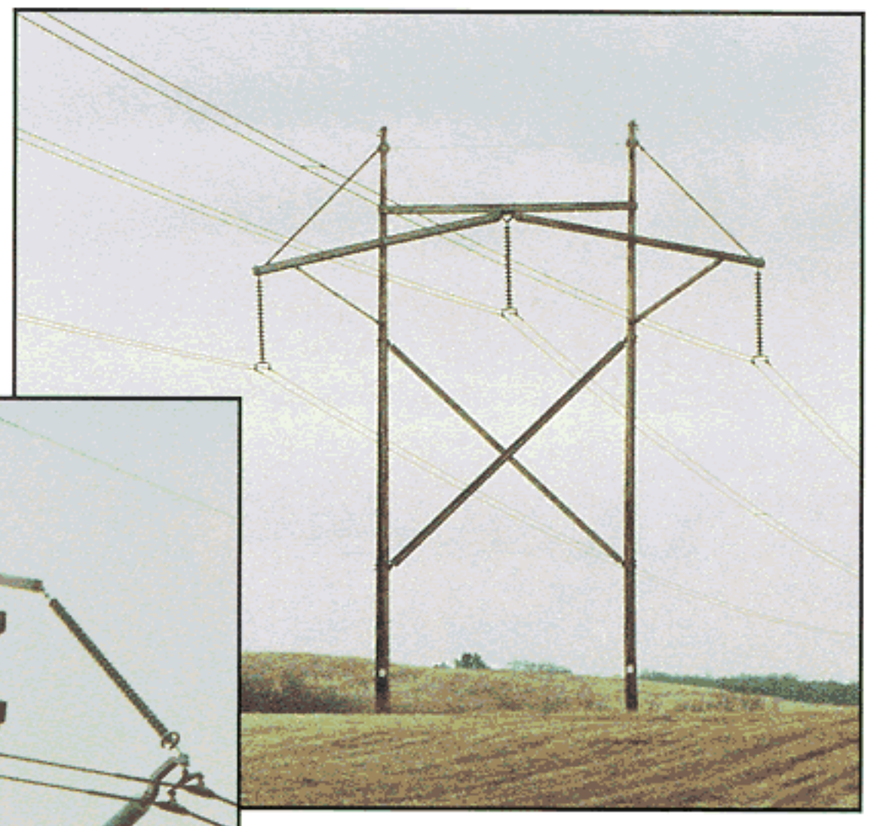
High-Strength
Supported Line Post

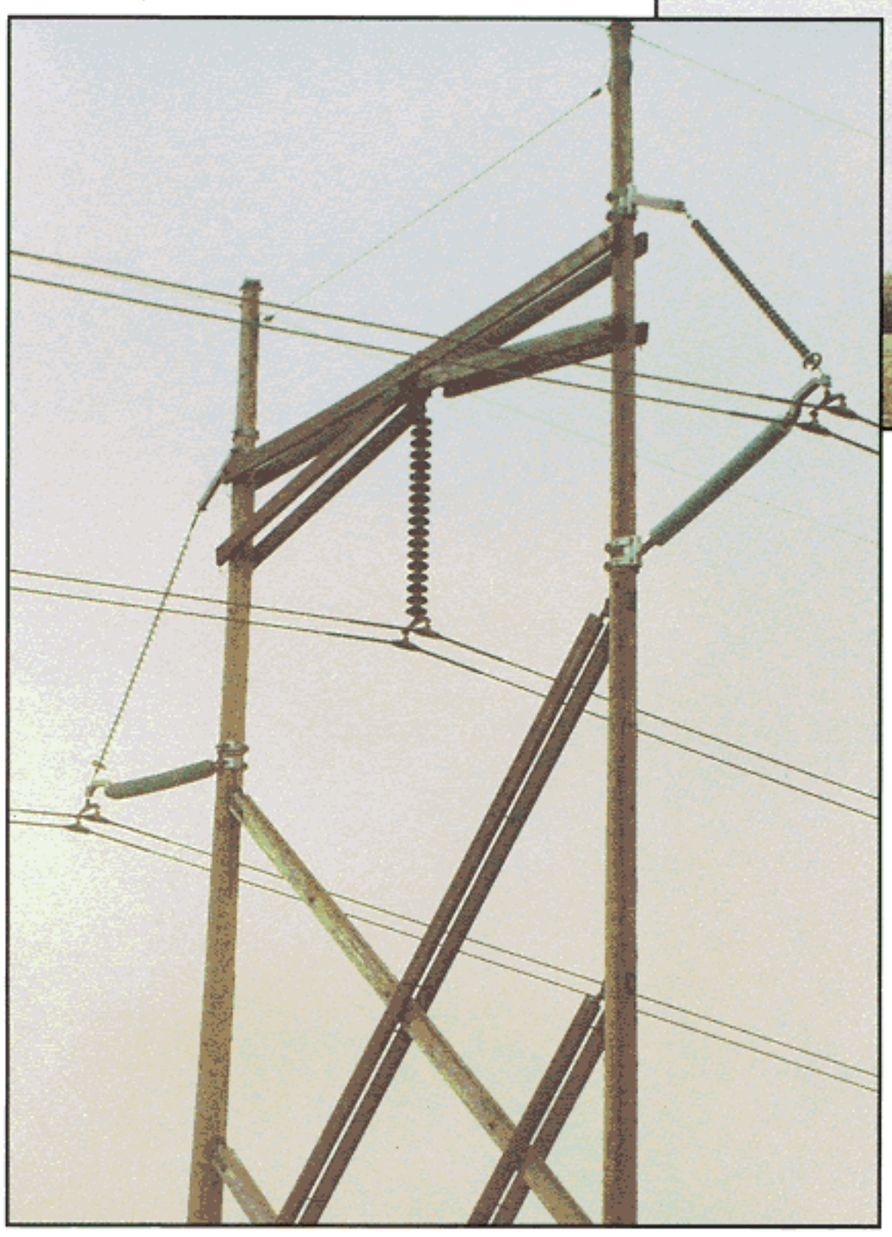
UPGRADING LINES

A 138 kV wood "H" frame construction was upgraded for higher temperature operation by changing insulator strings to Line Post insulators and moving location from suspension below the crossarm to rigid mounting above. Arm extensions beyond the pole were cut off to make room for horizontal Line Posts for outside phases.

"H" frame construction is upgraded from 115 to 230 kV on the same right-of-way by restraining outside phase conductors with horizontal vee assemblies and positioning the center phase conductors with vee strings. Construction permitted using cost-effective Class 2 poles for 1590 MCM ACSR conductor on 1,000 ft. spans.







Before: Outside phases on "K" frame structures of this design limited the power transfer capability of this 345 kV line. Maximum operating temperature was 120°F.

After: Raising conductor to new elevations permits greater sags associated with 212°F operation. More power can be transmitted and the need for expensive investment in new generation can be forestalled.

Capability was doubled on this 230 kV urban area line by adding a second conductor to the existing installation. Phase tension was kept the same to avoid replacing structures on dead ends and small angles. To offset increased sag, horizontal vees were used to elevate support points and develop the needed ground clearance.